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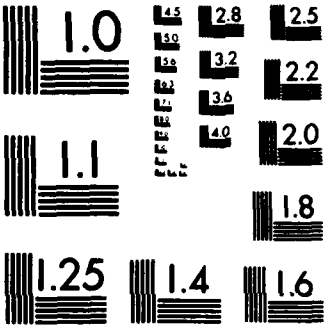

IRANIAN LONG PERIOD ARRAY SUPPORT

SEMIANNUAL REPORT

1 OCTOBER 1977 THROUGH 31 MARCH 1978

Prepared by

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This report summarizes activities under the program of technical support for the Iranian Long Period Array. The Iranian Long Period Array system consists of an array of seven remote seismic sensor installations, data communication links, and a central recording station. Personnel from the University of Tehran Institute of Geophysics operate the system. An on-site technical representative has been provided by Texas Instruments under contract from the Air Force Technical Applications Center to support operation and maintenance of the system and to provide training in these areas for designated personnel. Support services

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are also provided in the areas of furnishing consumable supplies, spare parts, engineering changes, etc. This report summarizes the major operation and maintenance problems encountered, outlines the training program, and lists recommended changes or improvements in the operation and maintenance of the system.

ABSTRACT

This report summarizes activities under the program of technical support for the Iranian Long Period Array. The Iranian Long Period Array system consists of an array of seven remote seismic sensor installations, data communication links, and a central recording station. Personnel from the University of Tehran Institute of Geophysics operate the system. An on-site technical representative has been provided by Texas Instruments under contract from the Air Force Technical Applications Center to support operation and maintenance of the system and to provide training in these areas for designated personnel. Support services are also provided in the areas of furnishing consumable supplies, spare parts, engineering changes, etc. This report summarizes the major operation and maintenance problems encountered, outlines the training program, and lists recommended changes or improvements in the operation and maintenance of the system.

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SECTION I
INTRODUCTION

The Iranian Long Period Array (ILPA) system is a seismic installation consisting of a central recording station (CRS) and an array of seven remote sites. Data received from the array is processed at the central recording station. Each remote site is made up of a three-component sensor system, data acquisition subsystem, telemetry subsystem, and power subsystem. The CRS consists of a station processor, a visual recording subsystem, a magnetic recording subsystem, a timing subsystem, a telemetry subsystem, and a power subsystem. Both long period (LP) and short period (SP) seismic data are recorded by the system. The system was established by a government-to-government agreement between the United States of America and the Imperial Government of Iran. Personnel from the University of Tehran Institute of Geophysics (UTIG) operate the system. The CRS is located in Tehran, Iran and the remote sites are centered in an area approximately 65 kilometers southwest of Tehran.

AFTAC has contracted with Texas Instruments Incorporated, under contract number F08606-78-C-0014, to provide technical support for the operation, maintenance, and continued training of UTIG personnel. This is a continuation of effort started under contract F08606-77-C-0016.

Tasks performed by Texas Instruments under the present contract include providing an on-site technical representative to support maintenance and operation of the system and to provide training in these areas for designated personnel. Support services are also provided in the areas of spare parts, consumable supplies, engineering changes, and emergency engineering services.

Events for the six month period ending 31 March 1978 are summarized in Section II. Operations of each of the subsystems are discussed in Section III. Reports on the array performance are referenced in Section IV. Section V outlines system improvements and modifications which have been implemented during the report period. Maintenance activities, categorized by equipment, are summarized in Section VI.

SECTION II
SUMMARY OF EVENTS

The purpose of this project is to provide technical support and training for the ILPA staff in the operation and maintenance of the array and its associated equipment. To accomplish this, Texas Instruments is providing an on-site technical representative to assist and train designated personnel on the program. Support services for the system are also provided by Texas Instruments. The program has been conducted by Texas Instruments under this contract and an earlier contract under the management of the Air Force Technical Applications Center (AFTAC) since 1 October 1976.

Activities during the past six months of the current program (1 October 1977 to 1 April 1978) have been categorized as being primary maintenance, operation, training, or support functions. However, each of the maintenance and operations activities include facets of the continuing training effort.

A. MAINTENANCE

A large portion of the maintenance effort during the past six month period was directed toward reconfiguration of the thermoelectric generators (TEGs) at the remote sites. These reconfigurations were undertaken as a result of recommendations made by representatives of Global Thermoelectric Power Systems Ltd., (the manufacturer) during a review of past remote site power problems. Line filters were installed in each of the fuel lines to reduce fouling of the burner orifices. The fuel tanks and lines were insulated with glass wool and plastic to reduce the effects of diurnal temperature variations. The pressure regulators were installed inside the TEGs and the pressures were adjusted to approximately seven psi. These changes and adjustments have resulted in marked improvement in reliability of the TEGs.

The data communication link between sites 5 and 6 and the CRS presents a continuing maintenance problem. The data link between site 5 and the CRS has been too noisy for maintaining synchronization and an unacceptable number of transmission errors were received from site 6. Attempts were made to locate an organization in Tehran that could undertake the realignment and retuning of the transmitters and receivers. A recommended course of action has been forwarded to AFTAC and is discussed in a later section of this report.

Several problems have been encountered with the Data Acquisition Control/Time Code Generator (DAC/TCG) unit. The problems have usually been corrected by reseating the integrated circuits on the printed wiring board.

Maintenance activity for the develocorders has generally been that required for cleaning the systems at regular intervals. The remaining maintenance effort was distributed over the remaining subsystems with no one subsystem requiring repeated maintenance attention. The limited number of personnel available for carrying out maintenance activities has dictated that some of the non-critical maintenance effort be postponed or cancelled.

B. OPERATION

System operation continues to be handled primarily by personnel from the UTIG. UTIG personnel also handled all transportation to the field sites and all administrative duties associated with operation of the system. All event detection and reporting was performed by personnel from UTIG. All sites were again calibrated during this report period.

C. TRAINING

Training has progressed as rapidly and as extensively as possible with the limited availability of personnel during the past six months. This has been primarily on-the-job training with limited formal training in specific areas. The limited number of people assigned to the program and the multiplicity of other responsibilities indicate that future training efforts will probably continue in this manner. A solderless breadboard was purchased for specific training on integrated circuits and their characteristics. The purchase of an integrated circuit in-circuit tester, such as a Fluke Trendar 200, has been recommended. In-depth knowledge of integrated circuits is not necessary with this type of tester. Its availability would simplify troubleshooting of the computer interfacing for the UTIG staff.

D. SUPPORT SERVICES

Spare parts for the system were shipped to the CRS via AFTAC/VSC throughout this report period as they were received in Dallas from the vendors. All of the 232 different spares items except four have been shipped to VSC. The remaining four items are scheduled for delivery in April.

Operating supplies for one year of station operation were also shipped during this report period. The supplies on hand at the CRS should be sufficient to support operations through September 1978.

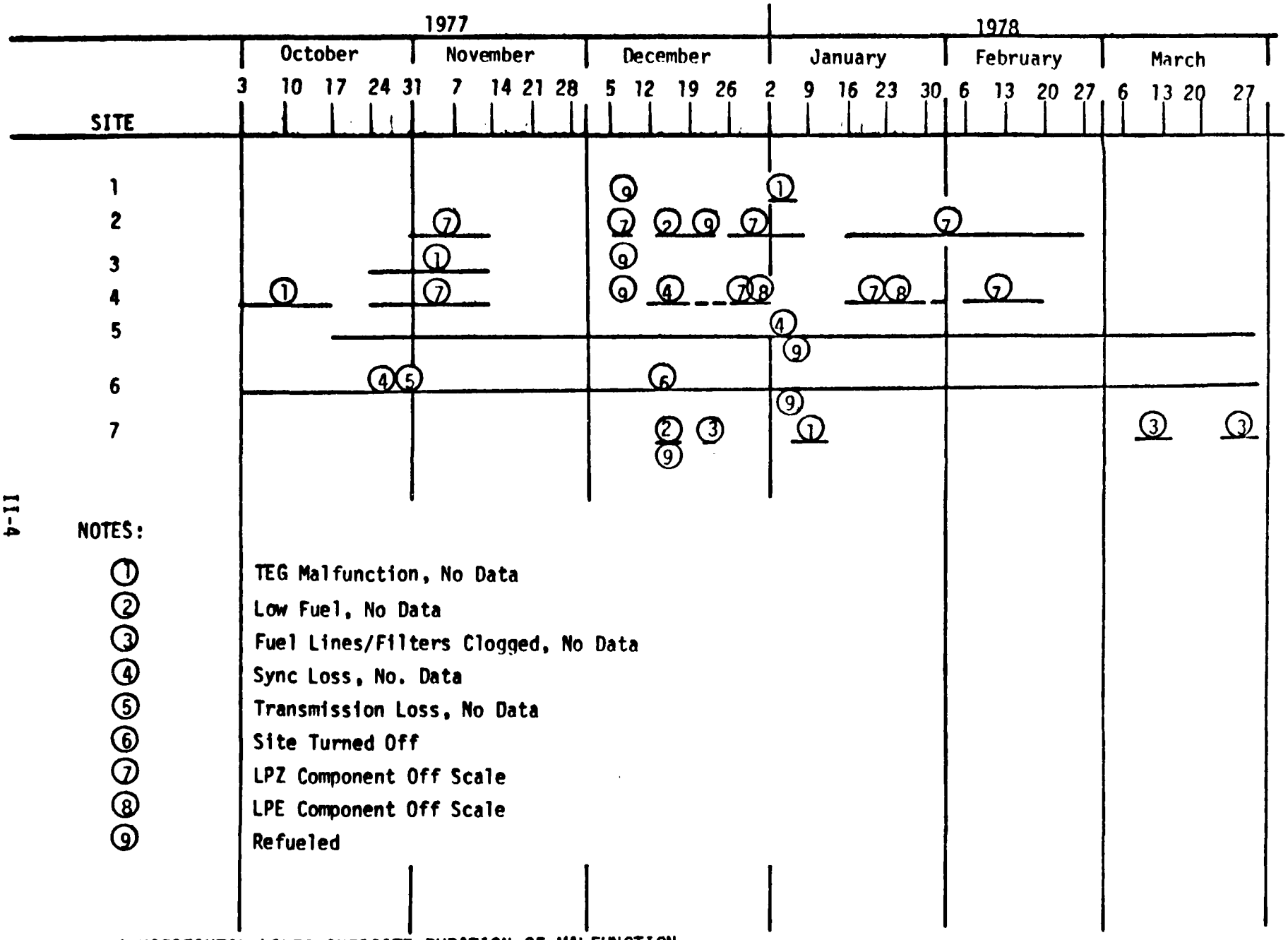
E. PERSONNEL

Mr. Wallace Daniel, Jr. was Texas Instruments on-site technical representative through February of this report period at which time he had completed one year in this capacity. Mr. Kenneth F. Heath worked with Mr. Daniel during February and has now assumed the responsibilities of on-site technical representative. It is planned that he will continue in this assignment for the remainder of the contract. Should any personnel changes be required, however, AFTAC/VSC will be apprised of such changes prior to any action being taken.

In March, Mr. Etessami was added to the UTIG ILPA staff as a technician. He will be working on the ILPA system on a part time basis, dividing his time between the ILPA system and a pollution monitoring system also operated by the UTIG. Mr. Etessami has completed seven semesters at the University of Tehran majoring in physics. He has some familiarity with digital logic, numbering systems, programming, and so forth. It appears that he will add a much needed capability in maintenance and operation of the system. A training program for Mr. Etessami has started.

F. SYSTEM STATUS

Status of the system, as reported to Dallas, is shown in Figure II-1.



* HORIZONTAL LINES INDICATE DURATION OF MALFUNCTION

FIGURE II-1. SYSTEM STATUS

SECTION III
SUBSYSTEM OPERATIONS

Subsystem operations continued to improve during the six month period ending 31 March 1978. The most notable operational improvements have been with the remote power subsystems and the power at the CRS. However, a portion of the data link continues to present operational problems.

It appears that the UTIG personnel associated with the ILPA system have had a number of other responsibilities in addition to the ILPA work during the past six months. Despite these added responsibilities, most of the system maintenance problems were resolved as soon as they occurred.

Performance of each of the subsystems during this report period is discussed in the following paragraphs.

A. CENTRAL PROCESSING UNITS

The central processing units were operational throughout the report period except when they were shut down for short periods of time for training purposes. After completing each computer troubleshooting training session, it is necessary to reload the operational software programs into the computers. The programs are loaded into the computers from magnetic tapes. A problem has been encountered in trying to load the program in CPU2. This has been traced to a problem in the digital transport interface drawer for CPU2. The problem can be circumvented by switching the cable for CPU2 from the digital transport interface for CPU2 to the digital transport interface for CPU1. The program can then be loaded in CPU2. After the program is loaded, the cables are returned to the original configuration, CPU2 is placed on-line and system operations are performed properly.

This condition presents an inconvenience to loading computer programs but does not adversely affect operations. Consequently, correction of the problem has not been given a high priority. To date the problem has been isolated to the tape-to-computer transmit section of the tape transport interface. All other sections appear to be operating normally. Data are properly recorded on tape when CPU2 is on-line. However, it is not possible to procure data using interface 2. The problem will be corrected as soon as personnel availability permits.

It was necessary to replace the keyboard on teleprinter 2 with one from the spare teleprinter. The keys on teleprinter 2 keyboard were sticking, making it difficult to enter commands.

On one occasion there was a modem and magnetic tape failure during a weekend. After restarting and resetting, no further failures have occurred.

B. TIMING SUBSYSTEM

Timing of the Time Code Generator (TCG) at the CRS was retarded one second on 1 January 1978 to comply with the additional second added to the year 1977. The date time on the SP and LP develocorders was also reset to the Julian date for 1978.

An inability to program LP signals to the monitor drum was traced to the DAC/TCG drawer. The problem was corrected by reseating the integrated circuits in that drawer. No other problems occurred with the timing subsystem.

C. MAGNETIC TAPE RECORDERS

A failure of tape transport 1 to log was found to be caused by corrosion around integrated circuits K2 and K3 in the formatter drawer. After cleaning the IC pins with alcohol the unit operated properly.

The only other problem associated with the Pertec tape recorders has been the tape-to-computer transmit problem discussed previously in sub-section A of this section.

Proper operation of the auxiliary data recorder was maintained throughout the report period. Another beginning of tape (BOT) light in the photo-sense assembly burned out and was again temporarily replaced with a light from a spare Pertec photosense assembly. The correct spare parts were subsequently received at the site and the exact replacement part can now be used on the auxiliary recorder. Only routine cleaning and checkout maintenance has been required in addition to the above.

D. DRUM RECORDERS

There were no malfunctions reported on the drum recorders during this report period. Noise appearing on the display channels at one time was found to result from spikes on the +5 vdc power supply for the signal conditioning drawer. This noise was minimized by proper adjustment of the voltage. Further checking may be necessary in the future if the noise increases.

E. DEVELOCORDERS

Continuing operation of the develocorders has necessitated the replacement or rework of a number of subsystem components. None of the malfunctions resulted in system down time, although the develocorder display of some data was lost. Most of the repairs were for the LP develocorder.

Loss of the time reference marks on the LP develocorder film was traced to the time fiducial box. No technical manual was available at the CRS for this unit. A manual was subsequently obtained through the Teledyne Geotech representative in Tehran and the problem was found to be the result of a failed 2N5062 SCR. It was necessary to ship spare SCRs from Dallas.

A film limit switch on the LP develocorder was sticking and was replaced. It was also necessary to replace the teflon roller guide on the LP unit.

The vertical component for LP channel 3 was lost but was corrected by cleaning the galvanometer. On the SP develocorder a repair of the solenoid valve adjustment was required. On both the LP and SP units it was necessary to replace the transport and tension rollers, the seal around the drain facility and processing cover. The above types of repairs are those which could normally be expected in the course of periodic cleaning of the units but will not affect the primary function of the system.

The SP filter for channel 19 has excessive noise and should be replaced. Spare filter boards are not available at the CRS.

F. CRS POWER

The automatic transfer switch for the three-phase, 62.5 KW generator was installed in October and has operated satisfactorily throughout this report period. The city power has failed frequently. During January for example, city power failures occurred an average of once per day.

The large generator failed to start on one occasion during a power failure on a week-end. However, the small emergency generator started, and took the load. When the large generator was subsequently checked it performed properly. The Onan service representative checked the system and replaced terminal block TB3. No further malfunctions have occurred.

The battery for the small generator is getting weak. The generator is now started once a day to maintain a charge on the battery. A new battery should be installed.

G. TELEMETRY

The telemetry subsystem functioned satisfactorily for all sites except 5 and 6. A number of attempts were made to improve data transmissions from sites 5 and 6 but none have been successful to date. The primary problem with site 5 telemetry has been the loss of the sync signal. It was first thought that the sync signal was lost in the control module of the transmit/receive modem board, however, this was disproved. It has been determined that the sync signal is present at both the input and output of the DAC board. The receiver at the CRS for site 5 has been checked and it was found to have essentially no squelch control.

Transmissions from site 6 showed excessive transmission errors and loss of sync through December. In January the site was turned off. Proper test equipment for tuning and realigning these portions of the telemetry system are not available at the CRS. An Iranian company, Irantronics, was located which has the capability and the facilities necessary for testing and tuning the telemetry elements. The cost information was forwarded to AFTAC/VSC.

When Mr. Wallace Daniel (Texas Instruments representative in Tehran) returned to Dallas, he brought the four transmitters and receivers associated with sites 5 and 6 with him for possible testing. This was first discussed with AFTAC/VSC. A cost estimate for retuning these units has been obtained from the successor to Emhiser-Rand, (manufacturer of the units). The cost estimate has been forwarded to AFTAC/VSC.

As of the end of this report period, the five remaining telemetry links continue to operate satisfactorily.

H. REMOTE SENSORS

Three long period components have displayed excessive noise on the develocorder traces. These are the vertical component for sites 2 and 4 and the east-west component for site 4. Data displays for these components are driven off scale. However, the filters for each of the channels appear to be functioning properly. A positive output with respect to the seismometer common has been measured for both the HI and LO outputs. The problem has been reviewed with personnel from Teledyne Geotech in Garland, Texas, who suggested that cable leakage could be the source of the problem. All other components of the remote site sensors have operated properly.

I. CALIBRATORS

Spare parts for the calibrators were received at the CRS. After the defective parts were replaced all units were operational. On several occasions a short period calibration would appear on the long period displays. This was a non-recurring problem, however, and was not definitively isolated. It was believed it may have originated in the DAC/TCG drawer.

J. REMOTE POWER SUBSYSTEMS

Significant improvement in the operating reliability of the remote site power subsystems was achieved during this report period. Most of the recommendations suggested by the representative of Global Thermoelectric Power Systems Ltd., during the previous report period have been implemented.

Line filters have been installed in each of the fuel lines, the pressure regulators have been installed inside the TEGs, and the fuel pressures have been adjusted at all sites. The fuel tanks and fuel lines have been insulated with glass wool and plastic, purchased and installed by the UTIG. The UTIG has also completed construction of shelters around the TEGs at four of the sites.

It was necessary to replace a leaking fuel filter at site 7 and to repair the filter installations at sites 2 and 6-relay. It was also necessary to replace one pressure regulator, an in-line filter, a low pressure gauge, and a burner assembly. The replaced burner assembly was found to have a bent venturi tube resulting in an improper air/gas mixture. On two occasions it was necessary to clean the sediment out of the regulator and fuel lines at site 7. This has not been required at any of the other sites during this report period. Site 7 went down again on 27 March 1978, and could not be repaired immediately because the truck was awaiting repair parts and the driver was on vacation. The fuel at site 7 appears to have a lot of moisture and may continue to present problems until the fuel tank is refilled.

SECTION IV
ARRAY PERFORMANCE

Evaluation of the Iranian Long Period Array was performed under contract F08606-77-C-0004 by Texas Instruments Incorporated at the Seismic Data Analysis Center in Alexandria, Virginia. Performance of the array is discussed in reports under that contract.

SECTION V
IMPROVEMENTS AND MODIFICATIONS

System and operational improvements made during the past six months include the following:

The automatic transfer switch for the 62.5 KW, three-phase generator was installed. The generator is now switched on automatically when there is a failure of the city power.

Modifications of the remote site power subsystems continued during this period. Line filters have been installed in the fuel lines, pressure regulators have been installed inside the TEGs, and the UTIG has insulated the fuel tanks and lines. TEG shelters were completed by the UTIG for four of the sites. As a result of these changes the remote site down time for TEG failures has shown a significant decrease.

Retuning and realignment of the components of the telemetry subsystem (13 transmitters, 19 receivers, and 11 duplexers) and recalibration of the test equipment are needed. Facilities for accomplishing this are not available at the CRS. A qualified firm capable of handling these jobs, Irantronics, was located in Tehran. Cost estimates for performing the work have been forwarded to AFTAC/VSC.

Operationally, improvements are needed in anticipating and scheduling predictable operations/maintenance activities. Replacement of spare parts used and refueling of remote site tanks are two activities of this type. Procedures for accomplishing these improvements will be suggested to the UTIG staff as appropriate.

COMPONENT FAILURES (1 OCTOBER 1978 TO 31 MARCH 1978)

TABLE VI-1

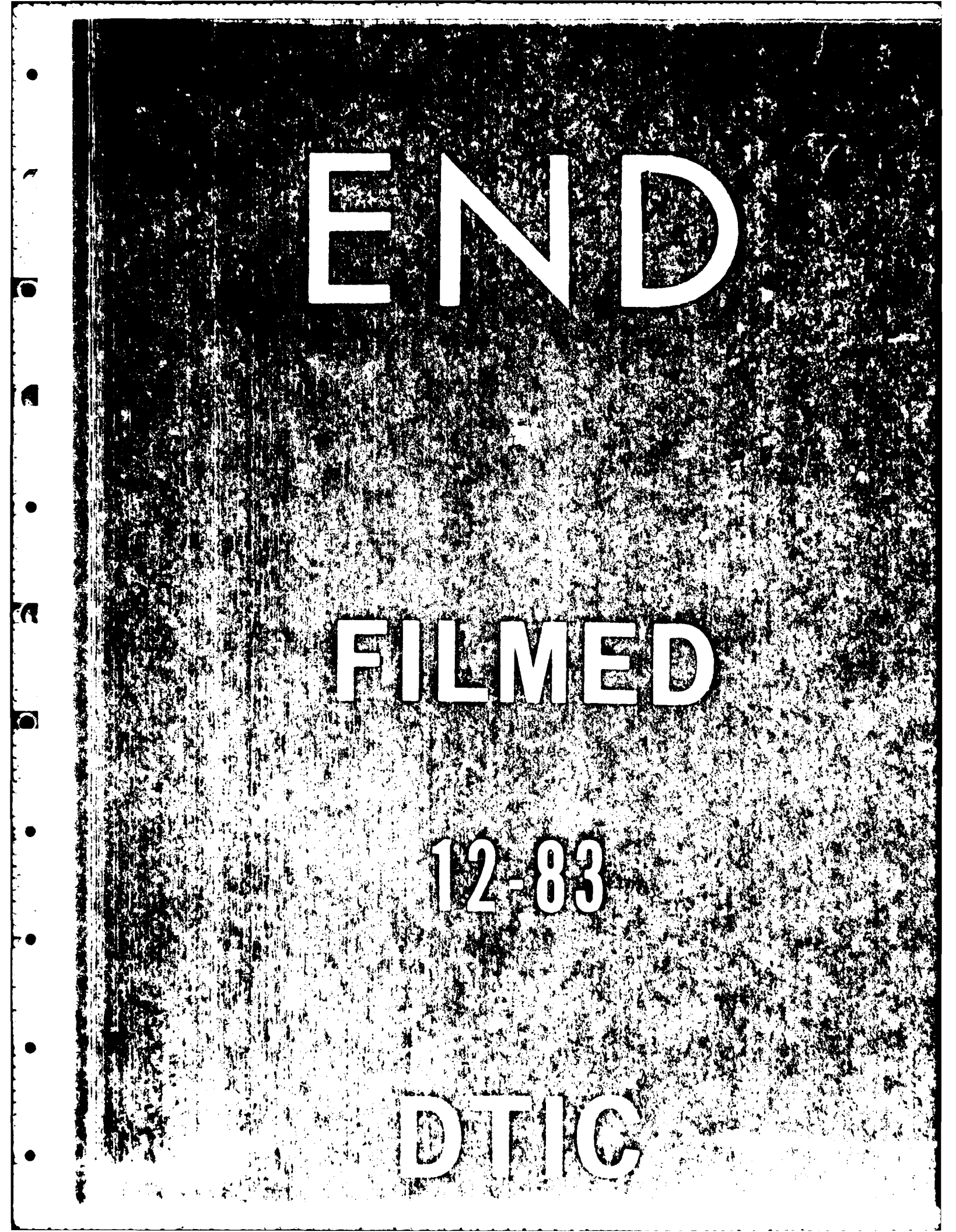
SUBSYSTEM	COMPONENT
Remote Sites	
Thermoelectric generator	In-line filter - leaks repaired at sites 2, 6R, and 7 - replaced filter at site 6R
	Burner assembly (bent venturi tube) - site 7
	Pressure regulator - site 1
	Low pressure gauge - site 4
Data Acquisition	SP smoothing filter replaced
	NOTE: LPZ filter at site 2 and LPZ and LPE filters at site 4 reading off scale. Cause not identified. Problem may be cable leakage.
Telemetry Subsystem	Loss of sync from site 5 and transmission errors from site 6. Cause not identified. Problem believed to be transmitter and receiver alignment.
CRS	
Time Fiducial Box	2N5026 SCR to be replaced.
Tape Formatter	Cleaned corrosion around K2 and K3 to permit tape transport number 1 to log.
UPS	Replaced battery exerciser timer (faulty motor)
Satellite Recorder	BOT light burned out - replaced with equivalent
LP Develocorder	Replaced sticking film limit switch.
	Replaced transport and tension rollers, sealing around drain facility, and processing cover - SP and LP develocorder.
DAC/TCG Drawer	Reseated ICs to permit programming LP signals onto monitor drum.
Digital Transport Interface (CPU2)	Unable to program system. Specific cause not identified.
Teleprinter	Replaced printhead.

SECTION VI
MAINTENANCE ACTIVITIES

Maintenance of the remote site TEGs, although considerably less than the previous report period, continued to require a large portion of the maintenance effort. Attempts to improve the quality of data transmissions from the remote sites also required extra effort. At the CRS, routine maintenance of the develocorders was the most time consuming activity.

Remote site visits were made at an average rate of slightly more than 1.1 visits per week. The International truck was not available for transportation to the field for approximately 25 percent of the time. This occurred during February and March. During this time the UTIG arranged for the use of a car for required trips.

Component failures during this report period are shown in Table VI-1.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